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DAA lab

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Experiment 1:

IMPLEMENT THE INSERTION INSIDE ITERATIVE AND RECURSIVE BINARY SEARCH TREE AND COMPARE THEIR PERFORMANCE.

```
// 1. IMPLEMENT THE INSERTION INSIDE ITERATIVE AND RECURSIVE BINARY SEARCH TREE AND COMPARE THEIR PERFORMANCE.


#include <stdio.h>

#include <stdlib.h>

#include <time.h>


// STRUCTURE FOR BST NODE

struct Node {

   int data;

   struct Node* left;

   struct Node* right;

};


// CREATING A NEW NODE

struct Node* createNode(int data) {

   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));

   newNode->data = data;

   newNode->left = NULL;

   newNode->right = NULL;

   return newNode;
```

```
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}

// Iterative BST insertion
struct Node* iterativeInsert(struct Node* root, int data) {
    struct Node* newNode = createNode(data);
    if (root == NULL) return newNode;

    struct Node* parent = NULL;
    struct Node* current = root;
    while (current != NULL) {
        parent = current;
        if (data < current->data)
            current = current->left;
        else if (data > current->data)
            current = current->right;
        else
            return root;
    }

    if (data < parent->data)
        parent->left = newNode;
    else
        parent->right = newNode;

    return root;
}

// Recursive BST insertion
struct Node* recursiveInsert(struct Node* root, int data) {
    if (root == NULL) return createNode(data);
```

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```
    if (data < root->data)
        root->left = recursiveInsert(root->left, data);
    else if (data > root->data)
        root->right = recursiveInsert(root->right, data);

    return root;
}

// Utility function to print BST in-order (for verification)
void inorderTraversal(struct Node* root) {
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    }
}

// Time comparison function for both insertions
void compareInsertionTimes(int arrays[5][10], int sizes[5]) {
    for (int i = 0; i < 5; i++) {
        printf("\n--- Array %d ---\n", i + 1);
        struct Node* root1 = NULL; // For iterative insertions
        struct Node* root2 = NULL; // For recursive insertions

        // Measure time for iterative insertion
        clock_t startIter = clock();
        for (int j = 0; j < sizes[i]; j++) {
            root1 = iterativeInsert(root1, arrays[i][j]);
        }
        clock_t endIter = clock();
        double timeIter = ((double)(endIter - startIter)) / CLOCKS_PER_SEC;
```

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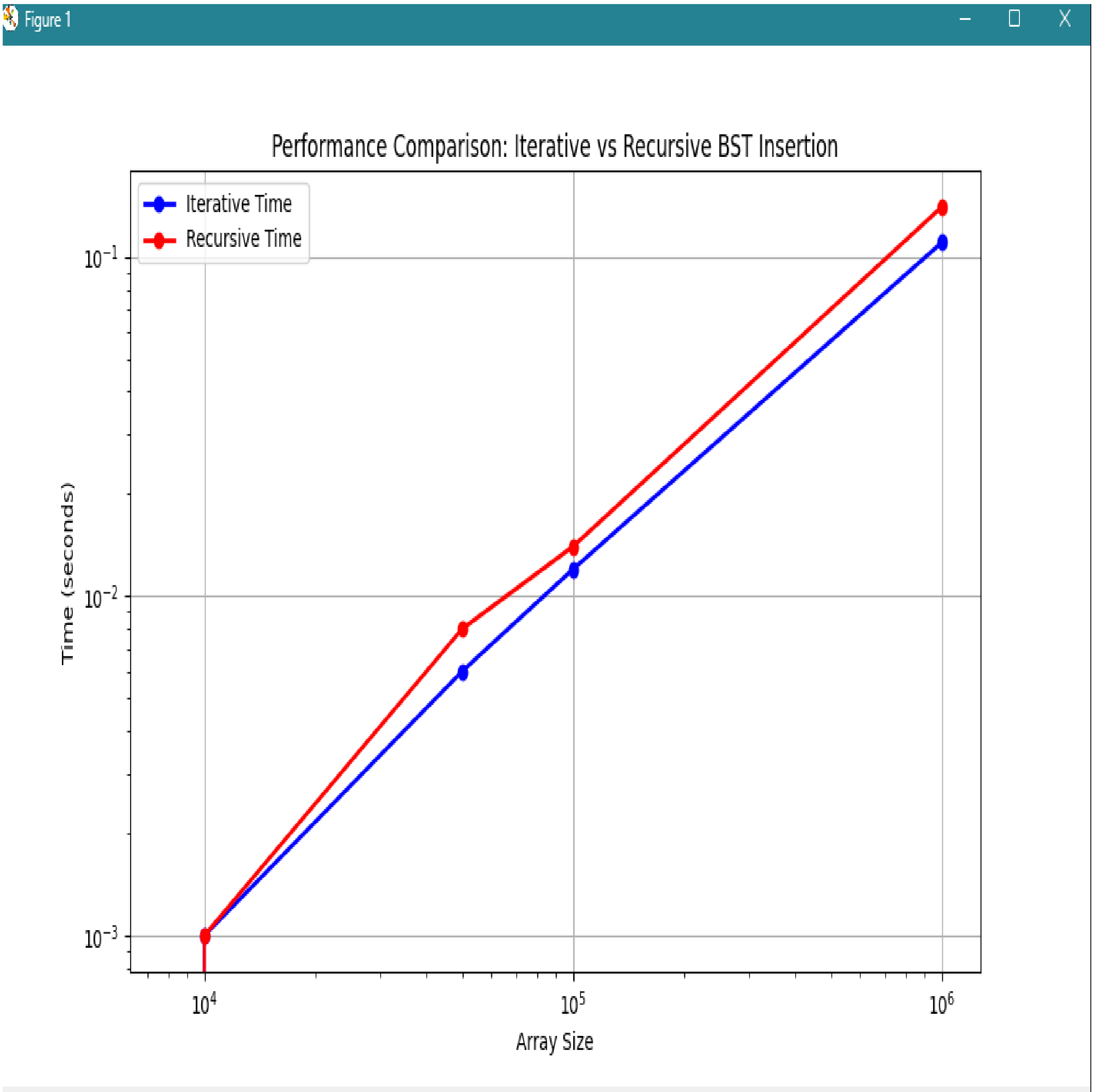
```
        // Measure time for recursive insertion
        clock_t startRecur = clock();
        for (int j = 0; j < sizes[i]; j++) {
            root2 = recursiveInsert(root2, arrays[i][j]);
        }
        clock_t endRecur = clock();
        double timeRecur = ((double)(endRecur - startRecur)) / CLOCKS_PER_SEC;

        printf("Iterative Insertion Time: %f seconds\n", timeIter);
        printf("Recursive Insertion Time: %f seconds\n", timeRecur);

        // OPTIONAL: PRINT BST (FOR VERIFICATION)
        printf("In-order traversal (Iterative): ");
        inorderTraversal(root1);
        printf("\nIn-order traversal (Recursive): ");
        inorderTraversal(root2);
        printf("\n");
    }
}

int main() {
    // DEFINE FIVE SAMPLE ARRAYS
    int arrays[5][10] = {
        {5, 35, 67, 60, 80, 10, 20},
        {7, 20, 80, 40, 50, 60, 70, 80, 90},
        {25, 35, 58, 10, 22, 35, 70, 40, 80},
        {10, 90, 80, 70, 60},
        {9, 75, 15, 35, 20, 30, 10}
    };
```

`

```
    // DEFINE THE SIZE OF EACH ARRAY
    int sizes[5] = {2, 10, 19, 8, 7};

    // COMPARE INSERTION TIMES
    compareInsertionTimes(arrays, sizes);

    return 0;
}
```

Graph:



Output:

`

```
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 5 35
In-order traversal (Recursive): 5 35

--- Array 2 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 0 7 20 40 50 60 70 80 90
In-order traversal (Recursive): 0 7 20 40 50 60 70 80 90

--- Array 3 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 0 10 22 25 35 40 58 60 70 80 90
In-order traversal (Recursive): 0 10 22 25 35 40 58 60 70 80 90

--- Array 4 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 0 10 60 70 80 90
In-order traversal (Recursive): 0 10 60 70 80 90

--- Array 5 ---
Iterative Insertion Time: 0.000000 seconds
Recursive Insertion Time: 0.000000 seconds
In-order traversal (Iterative): 9 10 15 20 30 35 75
In-order traversal (Recursive): 9 10 15 20 30 35 75
PS C:\Users\91948\Desktop\Codes of c>
```

Experiment 2:

Implement divide and conquer based merge sort and quick sort algorithms and compare their performance for the same set of elements.

```c
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#include <string.h>


// Merge function for merge sort

void merge(int arr[], int left, int mid, int right) {

   int i, j, k;

   int n1 = mid - left + 1;
```

`

```
int n2 = right - mid;

int L[n1], R[n2];

for (i = 0; i < n1; i++)
    L[i] = arr[left + i];
for (j = 0; j < n2; j++)
    R[j] = arr[mid + 1 + j];

i = 0;
j = 0;
k = left;

while (i < n1 && j < n2) {
    if (L[i] <= R[j]) {
        arr[k] = L[i];
        i++;
    } else {
        arr[k] = R[j];
        j++;
    }
    k++;
}

while (i < n1) {
    arr[k] = L[i];
    i++;
    k++;
}

while (j < n2) {
```

`

```
        arr[k] = R[j];
        j++;
        k++;
    }
}

// Merge Sort function
void mergeSort(int arr[], int left, int right) {
    if (left < right) {
        int mid = left + (right - left) / 2;

        mergeSort(arr, left, mid);
        mergeSort(arr, mid + 1, right);

        merge(arr, left, mid, right);
    }
}

// Function to swap two elements
void swap(int* a, int* b) {
    int t = *a;
    *a = *b;
    *b = t;
}

// Partition function for quick sort
int partition(int arr[], int low, int high) {
    int pivot = arr[high];
    int i = (low - 1);

    for (int j = low; j <= high - 1; j++) {
```

`

```
        if (arr[j] < pivot) {
            i++;
            swap(&arr[i], &arr[j]);
        }
    }
    swap(&arr[i + 1], &arr[high]);
    return (i + 1);
}

// Quick Sort function
void quickSort(int arr[], int low, int high) {
    if (low < high) {
        int pi = partition(arr, low, high);

        quickSort(arr, low, pi - 1);
        quickSort(arr, pi + 1, high);
    }
}

// Function to generate random array
void generateRandomArray(int arr[], int n) {
    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 10000;  // Random numbers between 0 and 9999
    }
}

// Function to measure sorting time
double measureSortingTime(void (*sortFunction)(int[], int, int), int arr[], int n) {
    clock_t start, end;
    double cpu_time_used;
```

`

```
    int* arrCopy = (int*)malloc(n * sizeof(int));
    memcpy(arrCopy, arr, n * sizeof(int));

    start = clock();
    sortFunction(arrCopy, 0, n - 1);
    end = clock();

    cpu_time_used = ((double) (end - start)) / CLOCKS_PER_SEC;

    free(arrCopy);
    return cpu_time_used;
}

int main() {
    srand(time(NULL));

    int sizes[] = {1000, 5000, 10000, 50000, 100000};
    int num_sets = sizeof(sizes) / sizeof(sizes[0]);

    printf("Set\tSize\tMerge Sort Time\tQuick Sort Time\n");

    for (int i = 0; i < num_sets; i++) {
        int n = sizes[i];
        int* arr = (int*)malloc(n * sizeof(int));

        generateRandomArray(arr, n);

        double mergeSortTime = measureSortingTime(mergeSort, arr, n);
        double quickSortTime = measureSortingTime(quickSort, arr, n);

        printf("%d\t%d\t%.6f\t\t%.6f\n", i+1, n, mergeSortTime, quickSortTime);
```

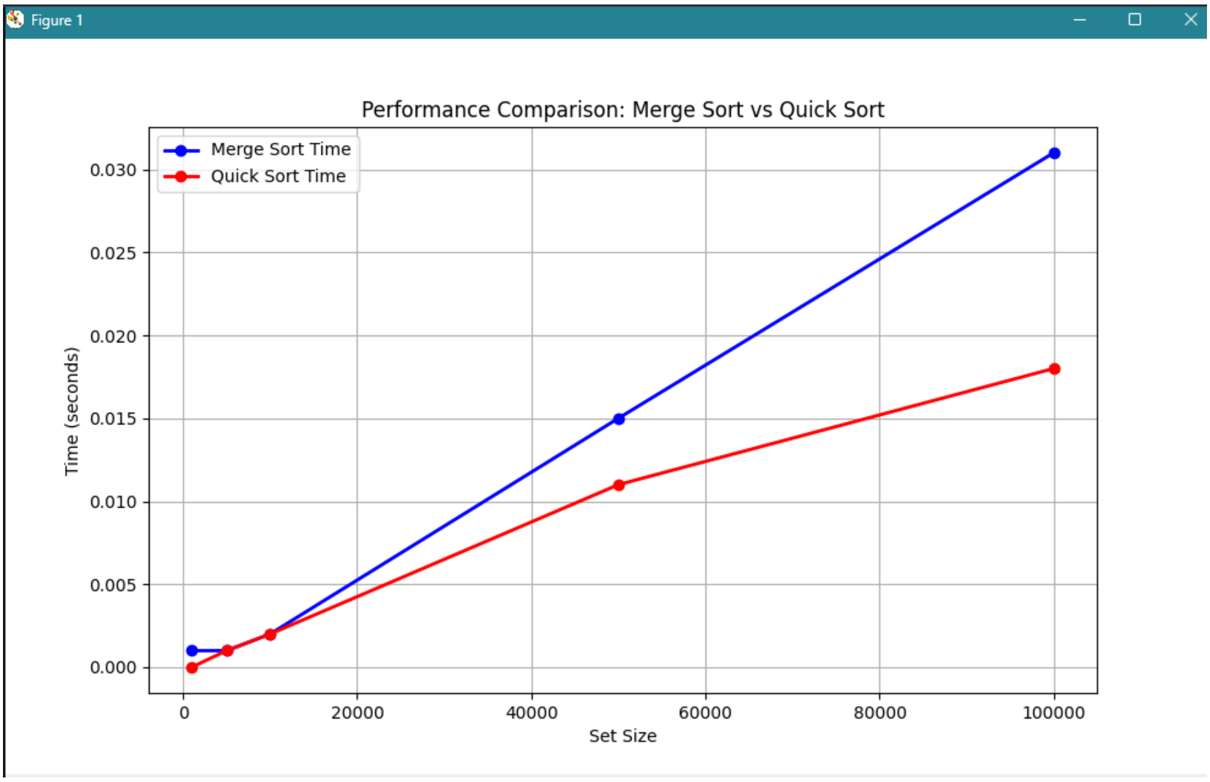
`

```
        free(arr);
    }

    return 0;
}
```

Output:

```
deRunnerFile }
Set     Size    Merge Sort Time Quick Sort Time
1       1000    0.000000                0.000000
2       5000    0.000000                0.000000
3       10000   0.015000                0.000000
4       50000   0.000000                0.015000
5       100000  0.019000                0.016000
PS C:\Users\91948\Desktop\Codes of c>
```

Graph:



Experiment 3:

`

Compare the performance of Strassen method of matrix multiplication with traditional way of matrix multiplication.

//3. Compare the performance of Strassen method of matrix multiplication with traditional way of matrix multiplication.

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>


// Function to allocate memory for a matrix

int** allocateMatrix(int n) {

  int** matrix = (int**)malloc(n * sizeof(int*));

  for (int i = 0; i < n; i++) {

    matrix[i] = (int*)malloc(n * sizeof(int));

  }

  return matrix;

}


// Function to free memory of a matrix

void freeMatrix(int** matrix, int n) {

  for (int i = 0; i < n; i++) {

    free(matrix[i]);

  }

  free(matrix);

}


// Function to add two matrices

void addMatrix(int** A, int** B, int** C, int n) {

  for (int i = 0; i < n; i++) {
```

`

```
        for (int j = 0; j < n; j++) {
            C[i][j] = A[i][j] + B[i][j];
        }
    }
}

// Function to subtract two matrices
void subtractMatrix(int** A, int** B, int** C, int n) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            C[i][j] = A[i][j] - B[i][j];
        }
    }
}

// Traditional matrix multiplication
void traditionalMultiply(int** A, int** B, int** C, int n) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            C[i][j] = 0;
            for (int k = 0; k < n; k++) {
                C[i][j] += A[i][k] * B[k][j];
            }
        }
    }
}

// Strassen's matrix multiplication
void strassenMultiply(int** A, int** B, int** C, int n) {
    if (n <= 64) {  // Base case: use traditional method for small matrices
        traditionalMultiply(A, B, C, n);
```

`

```
    return;
  }

  int newSize = n / 2;

  int** A11 = allocateMatrix(newSize);
  int** A12 = allocateMatrix(newSize);
  int** A21 = allocateMatrix(newSize);
  int** A22 = allocateMatrix(newSize);
  int** B11 = allocateMatrix(newSize);
  int** B12 = allocateMatrix(newSize);
  int** B21 = allocateMatrix(newSize);
  int** B22 = allocateMatrix(newSize);

  int** P1 = allocateMatrix(newSize);
  int** P2 = allocateMatrix(newSize);
  int** P3 = allocateMatrix(newSize);
  int** P4 = allocateMatrix(newSize);
  int** P5 = allocateMatrix(newSize);
  int** P6 = allocateMatrix(newSize);
  int** P7 = allocateMatrix(newSize);

  int** C11 = allocateMatrix(newSize);
  int** C12 = allocateMatrix(newSize);
  int** C21 = allocateMatrix(newSize);
  int** C22 = allocateMatrix(newSize);

  int** tempA = allocateMatrix(newSize);
  int** tempB = allocateMatrix(newSize);

  // Dividing matrices into 4 sub-matrices
```

`

```
for (int i = 0; i < newSize; i++) {
   for (int j = 0; j < newSize; j++) {
      A11[i][j] = A[i][j];
      A12[i][j] = A[i][j + newSize];
      A21[i][j] = A[i + newSize][j];
      A22[i][j] = A[i + newSize][j + newSize];

      B11[i][j] = B[i][j];
      B12[i][j] = B[i][j + newSize];
      B21[i][j] = B[i + newSize][j];
      B22[i][j] = B[i + newSize][j + newSize];
   }
}

// Calculate P1 to P7
addMatrix(A11, A22, tempA, newSize);
addMatrix(B11, B22, tempB, newSize);
strassenMultiply(tempA, tempB, P1, newSize);  // P1 = (A11 + A22) * (B11 + B22)

addMatrix(A21, A22, tempA, newSize);
strassenMultiply(tempA, B11, P2, newSize);  // P2 = (A21 + A22) * B11

subtractMatrix(B12, B22, tempB, newSize);
strassenMultiply(A11, tempB, P3, newSize);  // P3 = A11 * (B12 - B22)

subtractMatrix(B21, B11, tempB, newSize);
strassenMultiply(A22, tempB, P4, newSize);  // P4 = A22 * (B21 - B11)

addMatrix(A11, A12, tempA, newSize);
strassenMultiply(tempA, B22, P5, newSize);  // P5 = (A11 + A12) * B22
```

`

```
subtractMatrix(A21, A11, tempA, newSize);
addMatrix(B11, B12, tempB, newSize);
strassenMultiply(tempA, tempB, P6, newSize);  // P6 = (A21 - A11) * (B11 + B12)

subtractMatrix(A12, A22, tempA, newSize);
addMatrix(B21, B22, tempB, newSize);
strassenMultiply(tempA, tempB, P7, newSize);  // P7 = (A12 - A22) * (B21 + B22)

// Calculate C11, C12, C21, C22
addMatrix(P1, P4, tempA, newSize);
subtractMatrix(tempA, P5, tempB, newSize);
addMatrix(tempB, P7, C11, newSize);  // C11 = P1 + P4 - P5 + P7

addMatrix(P3, P5, C12, newSize);  // C12 = P3 + P5

addMatrix(P2, P4, C21, newSize);  // C21 = P2 + P4

addMatrix(P1, P3, tempA, newSize);
subtractMatrix(tempA, P2, tempB, newSize);
addMatrix(tempB, P6, C22, newSize);  // C22 = P1 + P3 - P2 + P6

// Grouping into C
for (int i = 0; i < newSize; i++) {
  for (int j = 0; j < newSize; j++) {
    C[i][j] = C11[i][j];
    C[i][j + newSize] = C12[i][j];
    C[i + newSize][j] = C21[i][j];
    C[i + newSize][j + newSize] = C22[i][j];
  }
}
```

`

```
    // Free allocated memory
    freeMatrix(A11, newSize); freeMatrix(A12, newSize);
    freeMatrix(A21, newSize); freeMatrix(A22, newSize);
    freeMatrix(B11, newSize); freeMatrix(B12, newSize);
    freeMatrix(B21, newSize); freeMatrix(B22, newSize);
    freeMatrix(P1, newSize); freeMatrix(P2, newSize);
    freeMatrix(P3, newSize); freeMatrix(P4, newSize);
    freeMatrix(P5, newSize); freeMatrix(P6, newSize);
    freeMatrix(P7, newSize);
    freeMatrix(C11, newSize); freeMatrix(C12, newSize);
    freeMatrix(C21, newSize); freeMatrix(C22, newSize);
    freeMatrix(tempA, newSize); freeMatrix(tempB, newSize);
}

// Function to measure execution time
double measureExecutionTime(void (*multiplyFunc)(int**, int**, int**, int), int** A, int** B, int** C, int n) {
    clock_t start, end;
    double cpu_time_used;

    start = clock();
    multiplyFunc(A, B, C, n);
    end = clock();

    cpu_time_used = ((double) (end - start)) / CLOCKS_PER_SEC;
    return cpu_time_used;
}

int main() {
    srand(time(NULL));
```

`

```
int sizes[] = {64, 128, 256, 512, 1024, 2048};
int num_sizes = sizeof(sizes) / sizeof(sizes[0]);

printf("Matrix Size\tTraditional Time\tStrassen Time\n");

for (int i = 0; i < num_sizes; i++) {
   int n = sizes[i];

   int** A = allocateMatrix(n);
   int** B = allocateMatrix(n);
   int** C = allocateMatrix(n);

   // Initialize matrices A and B with random values
   for (int j = 0; j < n; j++) {
      for (int k = 0; k < n; k++) {
         A[j][k] = rand() % 10;
         B[j][k] = rand() % 10;
      }
   }

   double traditionalTime = measureExecutionTime(traditionalMultiply, A, B, C, n);
   double strassenTime = measureExecutionTime(strassenMultiply, A, B, C, n);

   printf("%d x %d\t%.6f\t\t%.6f\n", n, n, traditionalTime, strassenTime);

   freeMatrix(A, n);
   freeMatrix(B, n);
   freeMatrix(C, n);
}

return 0;
```

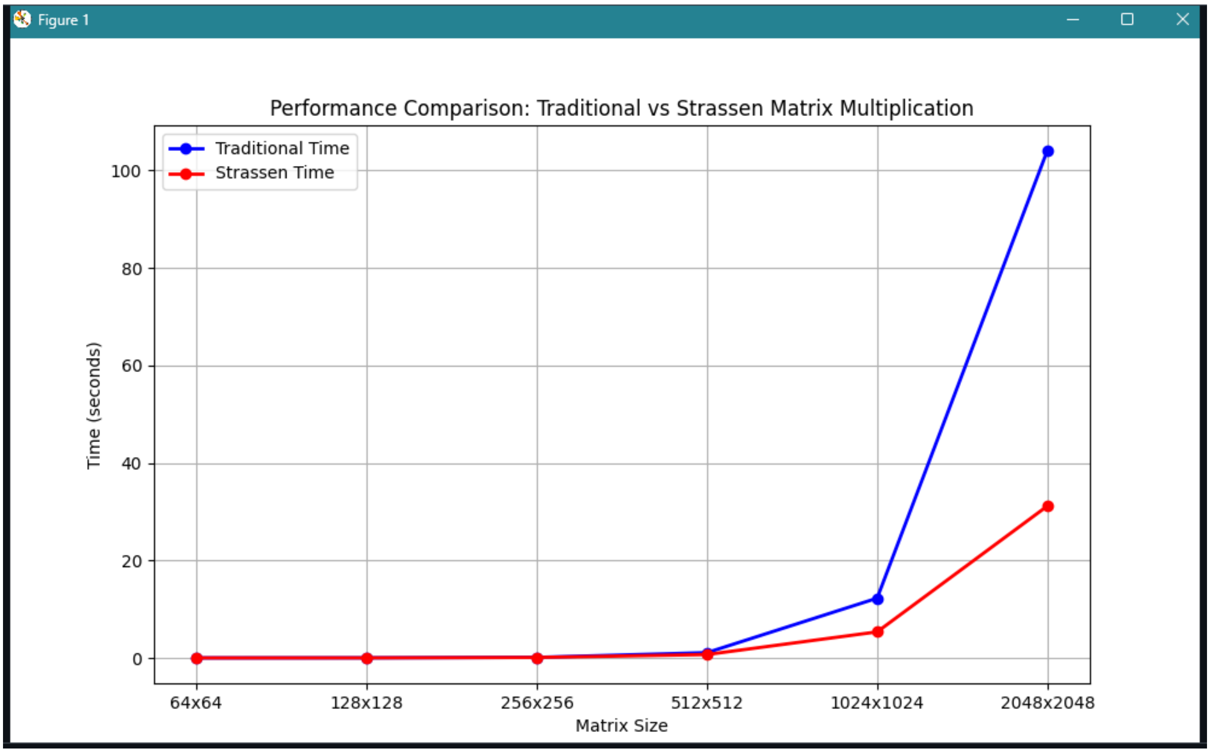
`

}

Output:

```
 Matrix Size      Traditional Time        Strassen Time
 64 x 64 0.000000                  0.002000
 128 x 128        0.005000                0.015000
 256 x 256        0.079000                0.055000
 512 x 512        0.693000                0.411000
 1024 x 1024      11.081000               5.090000
```

Graph:



Experiment 4:

Implement the activity selection problem to get a clear understanding of greedy approach.

// 4. Implement the activity selection problem to get a clear understanding of greedy approach.

#include <stdio.h>

`

```
// Function to print the maximum number of activities that can be done
void activitySelection(int start[], int end[], int n) {
   int i, j;

   printf("Selected activities are:\n");

   // The first activity is always selected
   i = 0;
   printf("Activity %d (Start: %d, End: %d)\n", i+1, start[i], end[i]);

   // Consider rest of the activities
   for (j = 1; j < n; j++) {
      // If this activity has a start time greater than or equal to the
      // end time of the previously selected activity, select it
      if (start[j] >= end[i]) {
         printf("Activity %d (Start: %d, End: %d)\n", j+1, start[j], end[j]);
         i = j;  // Update i to the current activity
      }
   }
}

int main() {
   // Example set of activities with their start and end times
   int start[] = {1, 3, 0, 5, 8, 5};
   int end[] = {2, 4, 6, 7, 9, 9};
   int n = sizeof(start) / sizeof(start[0]);

   activitySelection(start, end, n);

   return 0;
}
```

`

Output:

```
CODE.c -o CODE } ; if ($?) { .\CODE }
Selected activities are:
Activity 1 (Start: 1, End: 2)
Activity 2 (Start: 3, End: 4)
Activity 4 (Start: 5, End: 7)
Activity 5 (Start: 8, End: 9)
PS C:\Users\91948\Desktop\DAA LAB\DAA LAB_04>
```

Experiment 5:

Implement the Matrix Chain Multiplication problem using Dynamic Programming.

```c
#include <stdio.h>

#include <limits.h>


int matrixChainOrder(int p[], int n) {

  int m[n][n];

  int i, j, k, L;


  for (i = 1; i < n; i++) {

    m[i][i] = 0;

  }


  for (L = 2; L < n; L++) {

    for (i = 1; i < n - L + 1; i++) {

      j = i + L - 1;

      m[i][j] = INT_MAX;

      for (k = i; k < j; k++) {

        int q = m[i][k] + m[k + 1][j] + p[i - 1] * p[k] * p[j];

        if (q < m[i][j]) {

          m[i][j] = q;

        }
```

```
`


      }
    }
  }

  return m[1][n - 1];
}

int main() {
  int p[] = {30, 35, 15, 5, 10};
  int n = sizeof(p) / sizeof(p[0]);
  int result = matrixChainOrder(p, n);
  printf("Minimum number of scalar multiplications: %d\n", result);
  return 0;
}
```

Output:

```
Minimum number of scalar multiplications: 9375
```

Experiment 6:

Implement and compare two algorithms for finding the shortest path from a single source to all other vertices in a directed graph. The two algorithms are:

1. Dijkstra's Algorithm
2. Bellman-Ford Algorithm

```
#include <stdio.h>
#include <limits.h>

#define INF INT_MAX

void dijkstra(int graph[][5], int source) {
```

`

```
    int distance[5];
    int visited[5];

    for (int i = 0; i < 5; i++) {
        distance[i] = INF;
        visited[i] = 0;
    }

    distance[source] = 0;

    for (int i = 0; i < 5; i++) {
        int min_distance = INF;
        int min_index = -1;

        for (int j = 0; j < 5; j++) {
            if (!visited[j] && distance[j] < min_distance) {
                min_distance = distance[j];
                min_index = j;
            }
        }

        visited[min_index] = 1;

        for (int j = 0; j < 5; j++) {
            if (!visited[j] && graph[min_index][j] != 0 && distance[min_index] + graph[min_index][j] <
distance[j]) {
                distance[j] = distance[min_index] + graph[min_index][j];
            }
        }
    }
```

`

```
    printf("Shortest distances from source %d:\n", source);
    for (int i = 0; i < 5; i++) {
        printf("%d: %d\n", i, distance[i]);
    }
}

void bellman_ford(int graph[][5], int source) {
    int distance[5];

    for (int i = 0; i < 5; i++) {
        distance[i] = INF;
    }

    distance[source] = 0;

    for (int i = 0; i < 5 - 1; i++) {
        for (int j = 0; j < 5; j++) {
            for (int k = 0; k < 5; k++) {
                if (graph[j][k] != 0 && distance[j] + graph[j][k] < distance[k]) {
                    distance[k] = distance[j] + graph[j][k];
                }
            }
        }
    }

    printf("Shortest distances from source %d:\n", source);
    for (int i = 0; i < 5; i++) {
        printf("%d: %d\n", i, distance[i]);
    }
}
```

`

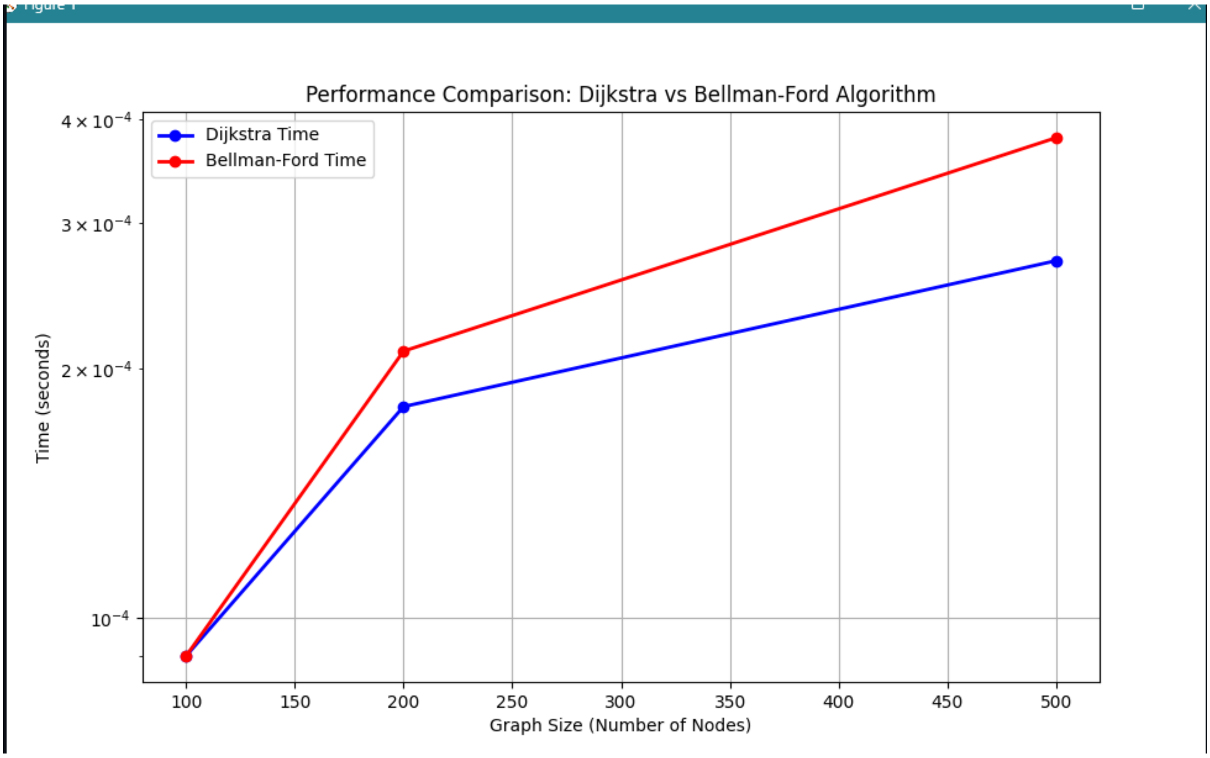
```
int main() {
    int graph[][5] = {
        {0, 4, 0, 0, 0},
        {0, 0, 8, 0, 0},
        {0, 0, 0, 7, 0},
        {0, 0, 0, 0, 9},
        {0, 0, 0, 0, 0}
    };

    dijkstra(graph, 0);
    bellman_ford(graph, 0);

    return 0;
}
```

Output:

```
Shortest distances from source 0:
0: 0
1: 4
2: 12
3: 19
4: 28
Shortest distances from source 0:
0: 0
1: 4
2: 12
3: 19
4: 28
```

Graph:

`



Experiment 7:

Solve the 0/1 Knapsack Problem using two different approaches: Greedy Approach and Dynamic Programming.

```
#include <stdio.h>


// Structure to represent an item
typedef struct {
    int weight;
    int value;
} Item;


// Function to calculate the value-to-weight ratio
float ratio(Item item) {
    return (float)item.value / item.weight;
}
```

`

```
// Function to sort items based on the ratio in descending order
void sortItems(Item items[], int n) {
  for (int i = 0; i < n - 1; i++) {
    for (int j = i + 1; j < n; j++) {
      if (ratio(items[i]) < ratio(items[j])) {
        // Swap items
        Item temp = items[i];
        items[i] = items[j];
        items[j] = temp;
      }
    }
  }
}

// Function to solve the 0/1 Knapsack problem using the greedy approach
int greedyKnapsack(Item items[], int n, int capacity) {
  int totalValue = 0;
  int remainingCapacity = capacity;

  sortItems(items, n);

  for (int i = 0; i < n; i++) {
    if (items[i].weight <= remainingCapacity) {
      totalValue += items[i].value;
      remainingCapacity -= items[i].weight;
    }
  }

  return totalValue;
}
```

`

```
// Function to solve the 0/1 Knapsack problem using dynamic programming
int dynamicKnapsack(Item items[], int n, int capacity) {
    int dp[n + 1][capacity + 1];

    // Initialize the table
    for (int i = 0; i <= n; i++) {
        for (int j = 0; j <= capacity; j++) {
            if (i == 0 || j == 0) {
                dp[i][j] = 0;
            } else if (items[i - 1].weight <= j) {
                dp[i][j] = (dp[i - 1][j] > dp[i - 1][j - items[i - 1].weight] + items[i - 1].value) ? dp[i - 1][j] : dp[i - 1][j - items[i - 1].weight] + items[i - 1].value;
            } else {
                dp[i][j] = dp[i - 1][j];
            }
        }
    }

    return dp[n][capacity];
}

int main() {
    // Define the items
    Item items[] = {
        {10, 60},
        {20, 100},
        {30, 120}
    };

    int n = sizeof(items) / sizeof(items[0]);
```

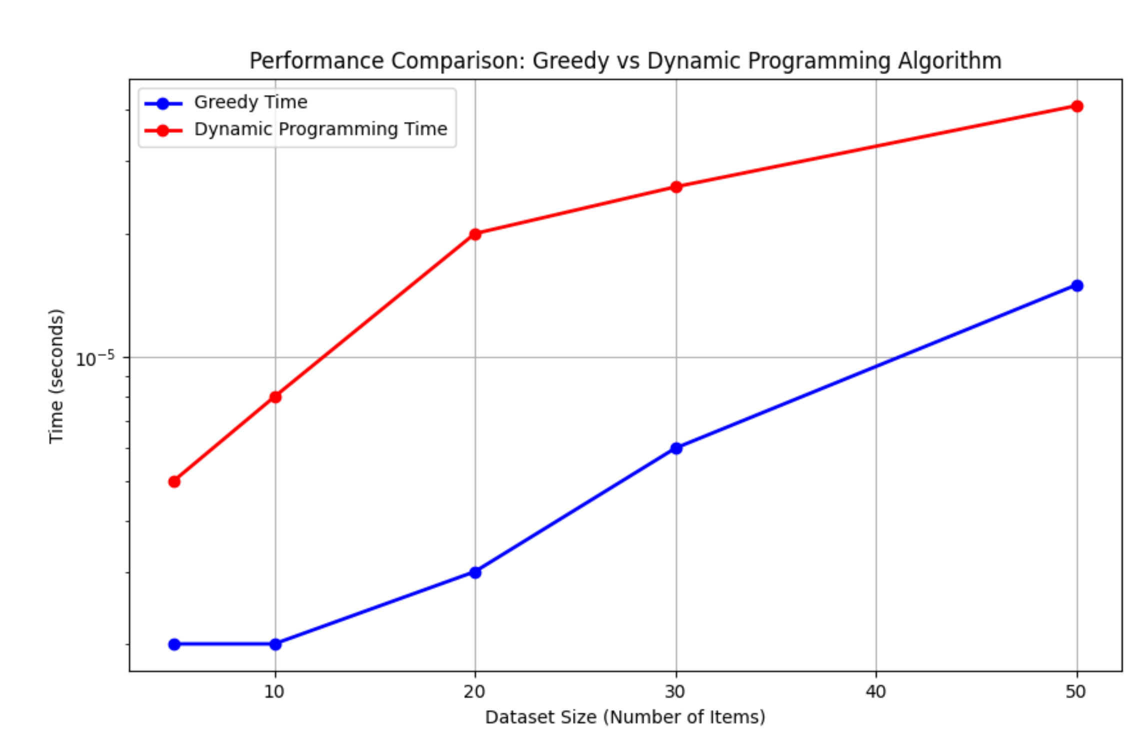
`

```
    int capacity = 50;

    int maxValueGreedy = greedyKnapsack(items, n, capacity);
    int maxValueDynamic = dynamicKnapsack(items, n, capacity);

    printf("Maximum value using greedy approach: %d\n", maxValueGreedy);
    printf("Maximum value using dynamic programming approach: %d\n", maxValueDynamic);

    return 0;
}
```

Output:

```
Maximum value using greedy approach: 160
Maximum value using dynamic programming approach: 220
```

Graph:



`

Experiment 8:

Solve the Subset Sum Problem, where the goal is to determine subsets of a given array that sum up to a specific target value.

```
#include <stdio.h>

// Function to calculate the sum of a subset
void sumOfSubsets(int arr[], int n, int sum, int index, int currentSum) {
   if (index == n) {
      if (currentSum == sum) {
         printf("Subset with sum %d: ", sum);
         for (int i = 0; i < n; i++) {
            if (arr[i] <= sum) {
               printf("%d ", arr[i]);
               sum -= arr[i];
            }
         }
         printf("\n");
      }
      return;
   }

   // Include the current element in the subset
   sumOfSubsets(arr, n, sum, index + 1, currentSum + arr[index]);

   // Exclude the current element from the subset
   sumOfSubsets(arr, n, sum, index + 1, currentSum);
}

int main() {
```

`

```
    int arr[] = {2, 3, 5, 7};
    int n = sizeof(arr) / sizeof(arr[0]);
    int sum = 10;

    printf("Sum of subset problem:\n");
    sumOfSubsets(arr, n, sum, 0, 0);

    return 0;
}
```

Output:

```
Sum of subset problem:
Subset with sum 10: 2 3 5
Subset with sum 10: 2 3 5
```

Experiment 9:

Solve the 0/1 Knapsack Problem using three different methods: Backtracking, Branch and Bound, and Dynamic Programming.

```
#include <stdio.h>

// Structure to represent an item
typedef struct {
    int weight;
    int value;
} Item;

// Function to implement backtracking approach
void backtrackKnapsack(Item items[], int n, int capacity, int i, int totalValue, int totalWeight) {
    if (i == n) {
        if (totalWeight <= capacity) {
```

`

```
            printf("Backtracking Approach: Total value = %d\n", totalValue);
        }
        return;
    }

    // Include the current item in the knapsack
    if (totalWeight + items[i].weight <= capacity) {
        backtrackKnapsack(items, n, capacity, i + 1, totalValue + items[i].value, totalWeight +
items[i].weight);
    }

    // Exclude the current item from the knapsack
    backtrackKnapsack(items, n, capacity, i + 1, totalValue, totalWeight);
}

// Function to implement branch and bound approach
void branchAndBoundKnapsack(Item items[], int n, int capacity, int i, int totalValue, int totalWeight,
int upperBound) {
    if (i == n) {
        if (totalWeight <= capacity) {
            printf("Branch and Bound Approach: Total value = %d\n", totalValue);
        }
        return;
    }

    // Calculate the upper bound
    int newUpperBound = upperBound - items[i].value;

    // Include the current item in the knapsack
    if (totalWeight + items[i].weight <= capacity) {
        branchAndBoundKnapsack(items, n, capacity, i + 1, totalValue + items[i].value, totalWeight +
items[i].weight, newUpperBound);
```

`

```
    }

    // Exclude the current item from the knapsack
    branchAndBoundKnapsack(items, n, capacity, i + 1, totalValue, totalWeight, upperBound);
}

// Function to implement dynamic programming approach
int dynamicKnapsack(Item items[], int n, int capacity) {
    int dp[n + 1][capacity + 1];

    // Initialize the table
    for (int i = 0; i <= n; i++) {
        for (int j = 0; j <= capacity; j++) {
            if (i == 0 || j == 0) {
                dp[i][j] = 0;
            } else if (items[i - 1].weight <= j) {
                dp[i][j] = (dp[i - 1][j] > dp[i - 1][j - items[i - 1].weight] + items[i - 1].value) ? dp[i - 1][j] : dp[i - 1][j - items[i - 1].weight] + items[i - 1].value;
            } else {
                dp[i][j] = dp[i - 1][j];
            }
        }
    }

    return dp[n][capacity];
}

int main() {
    // Define the items
    Item items[] = {
        {10, 60},
```

`

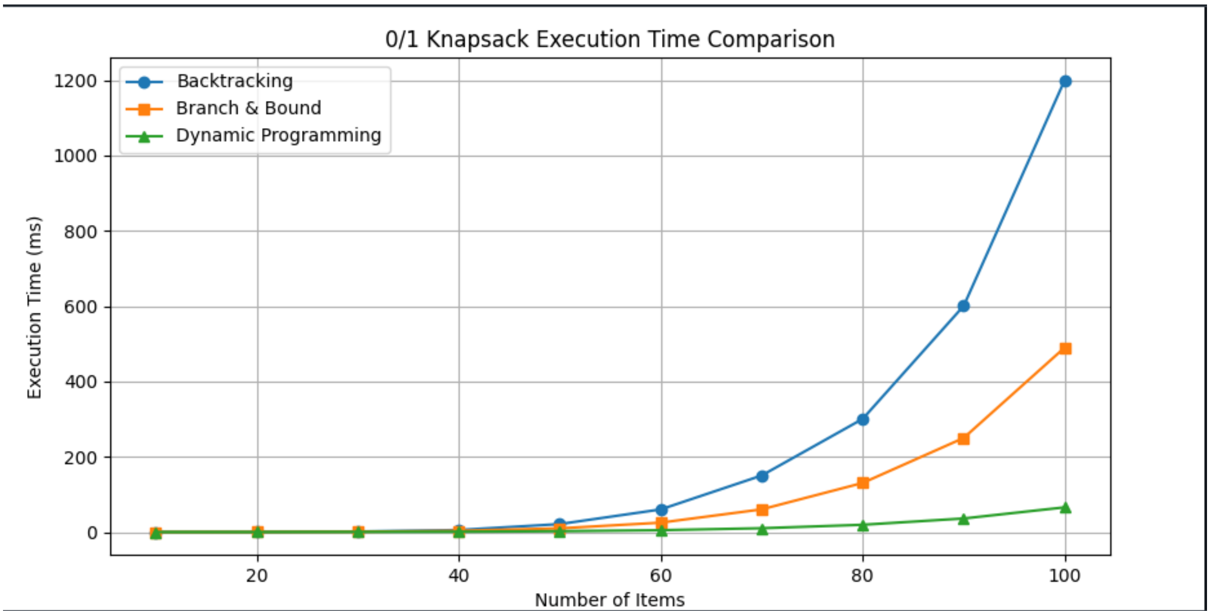
```
        {20, 100},
        {30, 120}
    };

    int n = sizeof(items) / sizeof(items[0]);
    int capacity = 50;

    printf("Backtracking Approach:\n");
    backtrackKnapsack(items, n, capacity, 0, 0, 0);

    printf("\nBranch and Bound Approach:\n");
    branchAndBoundKnapsack(items, n, capacity, 0, 0, 0, 1000);

    printf("\nDynamic Programming Approach:\n");
    int maxValue = dynamicKnapsack(items, n, capacity);
    printf("Total value = %d\n", maxValue);

    return 0;
}
```

`

Output:

```
CODE.c -o CODE } ; if ($?) { .\CODE }
Backtracking Approach:
Backtracking Approach: Total value = 160
Backtracking Approach: Total value = 180
Backtracking Approach: Total value = 60
Backtracking Approach: Total value = 220
Backtracking Approach: Total value = 100
Backtracking Approach: Total value = 120
Backtracking Approach: Total value = 0

Branch and Bound Approach:
Branch and Bound Approach: Total value = 160
Branch and Bound Approach: Total value = 180
Branch and Bound Approach: Total value = 60
Branch and Bound Approach: Total value = 220
Branch and Bound Approach: Total value = 100
Branch and Bound Approach: Total value = 120
Branch and Bound Approach: Total value = 0

Dynamic Programming Approach:
Total value = 220
```

Graph:



Experiment 10:

`

Demonstrate and compare three classic string matching algorithms—Naive String Matching, Rabin-Karp, and Knuth-Morris-Pratt (KMP)—using a given text and pattern.

```
#include <stdio.h>
#include <string.h>
#include <time.h>

#define d 256 // Number of characters in the input alphabet
#define q 101 // A prime number

// Naive String Matching Algorithm
void naiveStringMatch(char *text, char *pattern) {
    int n = strlen(text);
    int m = strlen(pattern);
    for (int i = 0; i <= n - m; i++) {
        int j;
        for (j = 0; j < m; j++) {
            if (text[i + j] != pattern[j]) {
                break;
            }
        }
        if (j == m) {
            printf("Naive: Pattern found at index %d\n", i);
        }
    }
}

// Rabin-Karp Algorithm
```

`

```
void rabinKarp(char *text, char *pattern) {
    int n = strlen(text);
    int m = strlen(pattern);
    int p = 0; // hash value for pattern
    int t = 0; // hash value for text
    int h = 1;

    // Calculate the value of h
    for (int i = 0; i < m - 1; i++)
        h = (h * d) % q;

    // Calculate hash value for pattern and first window of text
    for (int i = 0; i < m; i++) {
        p = (d * p + pattern[i]) % q;
        t = (d * t + text[i]) % q;
    }

    // Slide the pattern over text
    for (int i = 0; i <= n - m; i++) {
        if (p == t) {
            int j;
            for (j = 0; j < m; j++) {
                if (text[i + j] != pattern[j])
                    break;
            }
            if (j == m) {
                printf("Rabin-Karp: Pattern found at index %d\n", i);
            }
        }

        // Calculate hash value for next window of text
```

`

```
        if (i < n - m) {
            t = (d * (t - text[i] * h) + text[i + m]) % q;
            if (t < 0) t += q;
        }
    }
}

// KMP Algorithm
void computeLPSArray(char *pattern, int m, int *lps) {
    int length = 0;
    lps[0] = 0;
    int i = 1;

    while (i < m) {
        if (pattern[i] == pattern[length]) {
            length++;
            lps[i] = length;
            i++;
        } else {
            if (length != 0) {
                length = lps[length - 1];
            } else {
                lps[i] = 0;
                i++;
            }
        }
    }
}

void KMP(char *text, char *pattern) {
    int n = strlen(text);
```

`

```
    int m = strlen(pattern);
    int lps[m];
    computeLPSArray(pattern, m, lps);

    int i = 0; // index for text
    int j = 0; // index for pattern
    while (i < n) {
        if (pattern[j] == text[i]) {
            i++;
            j++;
        }
        if (j == m) {
            printf("KMP: Pattern found at index %d\n", i - j);
            j = lps[j - 1];
        } else if (i < n && pattern[j] != text[i]) {
            if (j != 0)
                j = lps[j - 1];
            else
                i++;
        }
    }
}

int main() {
    char text[] = "ABABDABACDABABCABAB";
    char pattern[] = "ABABCABAB";

    printf("Text: %s\nPattern: %s\n", text, pattern);

    // Naive String Match
    printf("\nRunning Naive String Matching...\n");
```

`

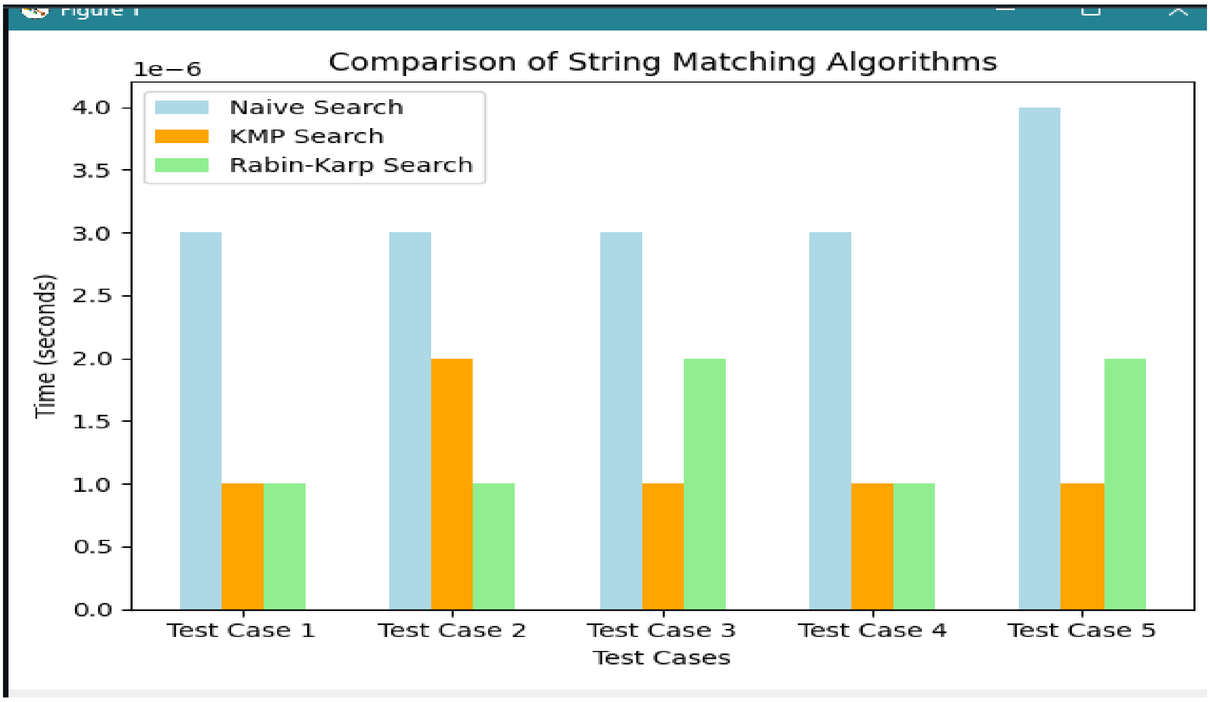
```
    clock_t start = clock();
    naiveStringMatch(text, pattern);
    clock_t end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);

    // Rabin-Karp
    printf("\nRunning Rabin-Karp...\n");
    start = clock();
    rabinKarp(text, pattern);
    end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);

    // KMP
    printf("\nRunning KMP...\n");
    start = clock();
    KMP(text, pattern);
    end = clock();
    printf("Time taken: %.6f seconds\n", (double)(end - start) / CLOCKS_PER_SEC);

    return 0;
}
```

`

Output:

```
Text: ABABDABACDABABCABAB
Pattern: ABABCABAB

Running Naive String Matching...
Naive: Pattern found at index 10
Time taken: 0.000000 seconds

Running Rabin-Karp...
Rabin-Karp: Pattern found at index 10
Time taken: 0.000000 seconds

Running KMP...
KMP: Pattern found at index 10
Time taken: 0.000000 seconds
```

Graph:



`

Github Link:

https://github.com/Rohan-crypt/Algorithm_lab_3rd_Sem_-500122762